

### Remarks

Further and favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

### Substance of Interview

Applicants' express their appreciation for the courtesy of a personal interview granted to their attorney by Examiner Watkins on December 24, 2009, as referred to in the Interview Summary mailed December 31, 2009.

At the beginning of the interview, Applicants' attorney noted the Examiner's error in his statement, as set forth in the Office Action, that Kazuo et al. (JP '438) discloses an Ra of 0.02 to 3 microns. Applicants' attorney pointed out that this reference actually discloses an Ra of 0.02 to 0.3 micron, and he noted that the Japanese language reference itself, as well as the English abstract of record, and the machine translation of the reference provided with the Office Action, all indicate an Ra of 0.02 to 0.3 micron. The Examiner noticed that the paragraph bridging pages 2 and 3 of the present specification, citing the JP '438 reference, refers to an Ra of 0.02 to 3 microns; and the Examiner then concluded that this must be where he got the Ra value referred to in the Office Action. Applicants' attorney informed the Examiner that he would amend this disclosure in the specification to recite the correct Ra range of 0.02 to 0.3 micron, and he expressed his opinion that this would not be new matter because the change would be supported by the JP '438 reference itself, which is cited at page 3, lines 4-5 of the specification. But the Examiner suggested that the disclosure in the paragraph bridging pages 2 and 3 of the specification could be an admission of prior art by Applicants (as indicated in the Interview Summary form). Applicants totally disagree with the Examiner's position in this regard, since the reference itself discloses an Ra value of 0.02 to 0.3 micron, and Applicants' attorney expressed this to the Examiner. The Examiner suggested that any amendment to the present specification in attempting to correct this might be more likely to be accepted if the amendment is accompanied by a Declaration indicating that the Ra of 0.02 to 3 microns at page 2, line 23 was a typographical error.

During the interview Applicants' attorney took the position that one of ordinary skill in the art would not have been motivated to increase the Ra value of JP '438 to 0.4 microns (which is the lower limit of the range in the amended claims set forth above and as discussed below).

The Examiner noted that the disclosure toward the end of paragraph [0016] of the machine translation of this reference discloses that if the Ra exceeds 0.3 micron "electrode formation of uniform thickness becomes difficult and the adhesion of a zirconia sheet falls further." But as noted in the Interview Summary form, the Examiner took the position that this disclosure teaches a degraded performance above a Ra of 0.3 micron, and not absolute destruction of the function of the reference.

As also indicated in the Interview Summary form, requirements for possible showings of unexpected results were discussed during the interview as a way to overcome the art rejections. Applicants' attorney did discuss the unexpected results. However, the Examiner indicated that any showing of unexpected results should compare the specific embodiment in the JP '438 reference which is closest to the presently claimed invention, with the presently claimed invention; and this comparison should involve both an Ra of 0.4 micron and an Ra of 3.0 microns for the present invention, i.e. both ends of the claimed range.

Applicants' attorney also discussed that the art-skilled would not combine the JP '438 and Hardee et al. references, because the Hardee et al. reference relates to a different technical field than the JP '438 reference, as shown in the "Inventive subject" row of the comparison table shown to the Examiner during the interview (a copy of which is submitted herewith). But the Examiner took the position that the claims of the present application are not limited to ceramics, but rather refer simply to "a sintered sheet", which could encompass the metal anode substrate of the Hardee et al. reference. The Examiner indicated that the argument against combining the references would be stronger if the present claims were limited to "a sintered ceramic sheet", which the Examiner agreed would be supported by the paragraph bridging pages 10 and 11 of the specification. [The Examiner stated that "a sintered sheet" could encompass a sintered metal sheet.]

#### Amendments

The error in the Ra range recited at page 2, line 23 of the present specification, which is for the JP '438 reference cited at page 3, lines 4-5, has now been corrected to a range of 0.02 to 0.3  $\mu\text{m}$ . As indicated above, this range is disclosed in the English abstract for the JP '438 reference and the machine translation for this reference as well as the reference itself, all of which are of record. One of ordinary skill in the art would clearly appreciate, after considering

the JP '438 reference, that the value of "3  $\mu\text{m}$ " at page 2, line 23 of the specification is a typographical error, which should be corrected to "0.3  $\mu\text{m}$ "; and therefore, this amendment does not constitute new matter (MPEP 2163.07II). Nevertheless, referring to the foregoing comments concerning the interview with the Examiner, Applicants are submitting herewith a Rule 132 Declaration confirming that the disclosure of "3  $\mu\text{m}$ " at page 2, line 23 of the specification was an inadvertent typographical error, which should have been "0.3  $\mu\text{m}$ ".

In view of these circumstances, Applicants respectfully submit that the amendment to page 2 of the specification does not constitute new matter.

Each of claims 1-3, which are the only independent claims in the application, has been amended to refer to a sintered **ceramic** sheet. As indicated above, this amendment is supported by the paragraph bridging pages 10 and 11 of the specification. As also indicated above, the Examiner noted during the interview that this amendment would buttress Applicants' argument against combining the JP '438 and Hardee et al. references.

Each of claims 1-3 has been further amended to increase the lower limit of the range for Ra to 0.4  $\mu\text{m}$ , which is supported by the disclosure at page 20, line 21 of the specification.

New claims 21-23 have been added to the application. These new claims are directed to a sintered zirconia oxide sheet as the sintered ceramic sheet, and are supported by page 32, lines 18-21 of the specification.

#### Patentability Arguments

The patentability of the presently claimed invention after entry of the foregoing amendments, over the disclosures of the references relied upon by the Examiner in rejecting the claims, will be apparent upon consideration of the following remarks.

Thus, the rejection of claims 1-4 and 8-9 under 35 U.S.C. §103(a) as being unpatentable over Kazuo et al. (JP '438, machine translation) in view of Hardee et al. (US '176) is respectfully traversed.

It is Applicants' position, as noted above in the comments concerning the interview with the Examiner, that one of ordinary skill in the art would not have been motivated to increase the Ra value of the JP '438 reference (disclosing an Ra range of 0.02 - 0.3  $\mu\text{m}$ ) to 0.4  $\mu\text{m}$ , which is the lower limit of the Ra range set forth in the presently claimed invention considering the amendments to the claims as set forth above. The Examiner noted, during the interview, that the

disclosure toward the end of paragraph [0016] of the machine translation of this reference indicates that if the Ra exceeds 0.3 micron, electrode formation of a uniform thickness becomes difficult and the adhesion of the zirconia sheet falls further; and the Examiner took the position that this disclosure teaches a degraded performance above a Ra of 0.3 micron, not absolute destruction of the function of the reference.

However, this does not explain why one of ordinary skill in the art would be **motivated** to increase the Ra value from 0.3  $\mu\text{m}$  to 0.4  $\mu\text{m}$ . In order to modify a prior art reference, the Examiner must articulate (1) a finding that there was some teaching, suggestion, or motivation, either in the reference itself or in the knowledge generally available to one of ordinary skill in the art, to modify the reference, (2) a finding that there was reasonable expectation of success, and (3) whatever additional findings based on the *Graham* factual inquiries may be necessary, in view of the facts of the case under consideration, to explain a conclusion of obviousness (MPEP 2143(G)). The object of the JP '438 reference is to improve the adhesion between the zirconia sheet and an electrode [0001]. This adhesion of the electrode to the zirconia sheet is "very important" [0004], for the reasons set forth in [0005]. The invention of the JP '438 reference is a technique which can join an electrode to a zirconia sheet "powerfully with high adhesion" [0008]. The reference discloses that if the Ra value is 0.02 - 0.3  $\mu\text{m}$ , these results can be achieved, and paragraph [0016] discloses that when Ra exceeds 0.3  $\mu\text{m}$ , electrode formation of uniform thickness becomes difficult and the adhesion of a zirconia sheet falls further. There is no logical reason why the art-skilled, looking at all of these disclosures cited above, would exceed an Ra value of 0.3  $\mu\text{m}$ , i.e. there is no suggestion or motivation to do so, and in fact, the art-skilled are cautioned against increasing the Ra value beyond 0.3  $\mu\text{m}$ .

As indicated above, [0008] of JP '438 has the object of improving adhesion of an electrode. This refers to adhesion when the electrode is formed ([0016]), and is not adhesion during electric generation, as the boundary face between a ceramic sheet and electrode was only visually observed immediately after printing the electrode in the Example ([0058]).

On the other hand, the "adhesion" in the present invention means an adhesion during electric generation or after electric generation, and the definition of the adhesion in the present invention is different from that in JP '438. For example, a determination was made whether the electrode was peeled or not from the electrolyte after electric generation for 200 hours in the Example described in the present specification.

The inventors of the present invention and JP '438, Messrs. HATA and AIKAWA, continued to study the sheet of JP '438 and found that the electrode sometimes peeled during electric generation even if the electrode is well adhered to a sheet when the electrode is formed, and sufficient electric generation property sometimes cannot be obtained when the sheet of JP '438 is used as electrolyte of a fuel cell. The present invention was completed as the result of continued study from JP '438.

It is described in [0016] of JP '438 that electrode formation with uniform thickness becomes difficult and the adhesion of a zirconia sheet falls when Ra exceeds 0.3  $\mu\text{m}$ . Therefore, it is hardly possible that Ra of the ceramic sheet for fuel cell is adjusted to more than 0.3  $\mu\text{m}$  if the person skilled in the art refers to JP '438.

On the other hand, the present inventors surprisingly made a ceramic sheet of which the Ra is more than 0.3  $\mu\text{m}$ , and printed electrodes on the sheet. As a result, the inventors found that peeling of electrodes from the sheet is prevented during electric generation though it is difficult to form an electrode with uniform thickness, and the electric generation property can be improved when the sheet is used as electrolyte of a fuel cell, to complete the present invention.

Actually, as shown in Table 3 of the present specification, when Ra of a zirconia sheet was set less than 0.3  $\mu\text{m}$  (0.08 - 0.17  $\mu\text{m}$ , Comparative Example 1), the electrodes were peeled after electric generation for 200 hours, though the electrodes were adhered to the sheet immediately after the electrodes were formed on the sheet.

Thus, although it is described in [0016] of JP '438 that electrode formation with uniform thickness **becomes difficult**, and the adhesion of a zirconia sheet falls when Ra exceeds 0.3  $\mu\text{m}$ , the present invention surprisingly achieves effects which are unpredictable from JP '438.

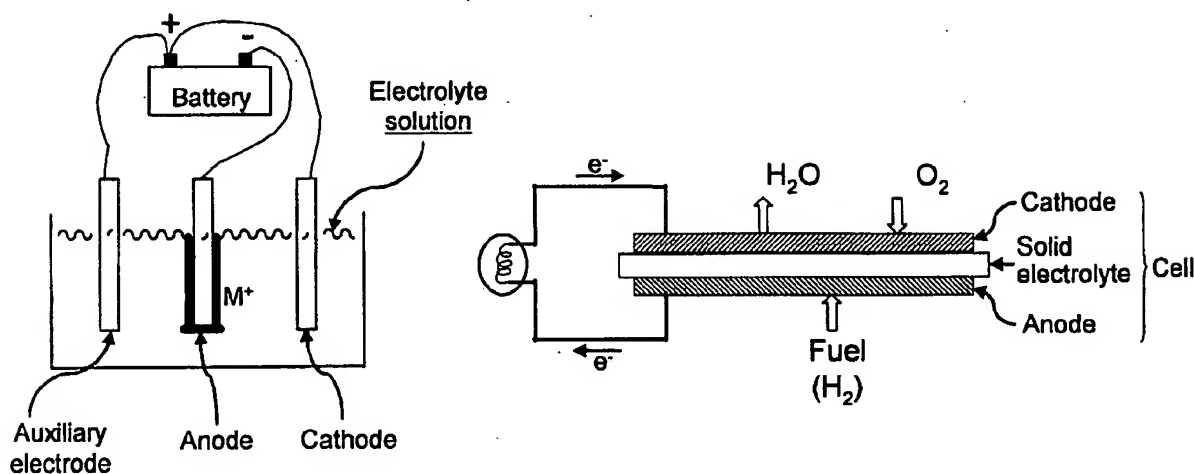
The range of Rz described in Hardee et al. is at least about 1,000 microinches (25.4  $\mu\text{m}$ ), and preferably about 1,500 to 3,500 microinches (38.1 to 88.9  $\mu\text{m}$ ).

On the other hand, the range of Rz of the present invention is "2.0 to 20  $\mu\text{m}$ ", so these ranges of Rz are clearly different from each other.

It is technically difficult to combine JP '438 with Hardee et al., attention in this regard being directed to the attached comparison tables between the present invention and Kazuo et al. (JP '438), and between the present invention and Hardee et al.

The invention of Hardee et al. relates to an anode for use in electrogalvanizing, electroplating, electroforming or electrowinning (col. 1, line 62 to col. 2, line 7). In other words,

the invention of Hardee et al. is **not** used for electric generation. On the contrary, electricity is consumed. In addition, electrolyte liquid is used in the invention of Hardee et al.



As demonstrated above, the technical field of Hardee et al. is entirely different from that of JP '438, in which electricity is generated and solid electrolyte is used.

Based on these considerations, Applicants take the position that one of ordinary skill in the art would not combine the teachings of the JP '438 and Hardee et al. references.

Furthermore, referring to the amended claims set forth above, the electrolyte sheet of the present invention comprises a sintered ceramic sheet, thus strengthening Applicants' argument in this regard, as suggested by the Examiner during the interview.

In view of these considerations, Applicants respectfully submit that the references applied by the Examiner in rejecting the claims do not establish a *prima facie* case of obviousness, and accordingly, there is no need for Applicants to present evidence of nonobviousness (MPEP 2142). Nevertheless, as discussed during the interview with the Examiner, the present invention does have an unexpected superior result as compared to the invention of the JP '438 reference, arising from the difference in Ra value between the present invention and the JP '438 reference.

In this regard, the reason why the Ra range is defined in JP '438 is only for improvement of adhesion between the sheet and electrodes ([0016]), and "electric power generation performance" is not sufficiently considered in the reference (please refer to page 2, line 18 - page 3, line 20 of the present specification).

In JP '438 electric power generation performance and endurance are described ([0062]), but they are merely associated with adhesion property before use, not with experimental data.

In JP '438, the adhesion property was evaluated only with SEM photographs of zirconia sheets, on which two electrodes were formed ([0057] - [0058] and Table 2). The adhesion property was evaluated just after production of a cell, but not after use. Therefore, it is not experimentally demonstrated in JP '438 whether the cell produced using the zirconia sheet of the reference is really excellent in electric power generation performance and endurance, or not.

Actually, when electric power generation performance and endurance were evaluated using the zirconia sheet included in the Ra range of JP '438 (Comparative Example 1 of the present specification), of which the Ra is 0.17  $\mu\text{m}$  and 0.08  $\mu\text{m}$ , electric power generation performance was not sufficient and a part of the electrodes was peeled during electric power generation (Table 3).

On the other hand, in the Example described in the present specification, a cell having three layers for SOFC was produced, the electric power generation test was continuously conducted for 200 hours, and electric power generation performances at an early stage and after 200 hours were evaluated, and peeling of the electrode was checked. The surface roughness of the electrolyte sheet was specified in the present invention based on the result of the test.

Specifically, although the cell of JP '438 is excellent in adhesion property before use, when the cell having the zirconia sheet included in the Ra range of this reference (Comparative Example 1 of the present specification), of which the Ra is 0.17  $\mu\text{m}$  and 0.08  $\mu\text{m}$ , was evaluated with the electric power generation test continuously for 200 hours, it is apparent that both electric power generation performance at an early stage and after 200 hours were inferior to the case of the electrolyte of the present invention (Table 3). In addition, a part of the electrodes was peeled after electric power generation continuously for 200 hours, when the zirconia sheet included in the Ra range of JP '438 (Comparative Example 1 of the specification), of which the Ra is 0.17  $\mu\text{m}$  and 0.08  $\mu\text{m}$ , was used (Table 3).

On the other hand, the numerical range of Ra of the present invention is "0.4 to 3.0  $\mu\text{m}$ ". This range is defined in consideration of the amount of electric power generation per unit area of the electrode as well as both formability and adhesion of the electrode film (page 20, lines 16-23). As proof of this, it is apparent that the maximum output density in the early stage, that is, electric power generation performance, is improved with the electrolyte sheet of which Ra is 0.79  $\mu\text{m}$  and 0.55  $\mu\text{m}$  (Example 1 in the specification), compared with the case of the corresponding sheet of which Ra is 0.17  $\mu\text{m}$  and 0.08  $\mu\text{m}$  (Comparative Example 1) (Tables 2

and 3). Specifically, when comparing the cases of Example 1 and Comparative Example 1, only of which surface roughness values are different from each other, the maximum output density in the early stage of Example 1 is improved by 15% compared with Comparative Example 1.

In addition, when the electrolytes of the present invention were used, electric power generation property was excellent and peeling of electrodes was not observed even after electric power generation continuously for 200 hours (Table 3).

As mentioned above, electric power generation performance in case of using the electrolyte of the present invention is dramatically improved compared to the case of using the electrolyte of JP '438, and the improvement effect of electric power generation performance is not described or suggested in Hardee et al.; therefore, the above mentioned effect of the present invention is unpredictable from JP '438 and Hardee et al..

Although the Examiner, during the interview, suggested that any showing of unexpected results should compare the present invention with the JP '438 reference over the range of 0.4 - 3.0  $\mu\text{m}$  for Ra, Applicants respectfully submit that the showing set forth in the present specification, as discussed above in detail, is adequate to establish unexpected results (even though as indicated above, such a showing of unexpected results is not necessary because the references do not establish a presumption of obviousness). The Examiner has offered no reason why similar results would not be obtained with any other particular Ra value within the presently claimed range; and in fact, considering the results as discussed above, Applicants respectfully submit that the art-skilled would expect similar results over the claimed range.

For the reasons set forth above, Applicants respectfully submit that the presently claimed invention is clearly patentable over the applied references.



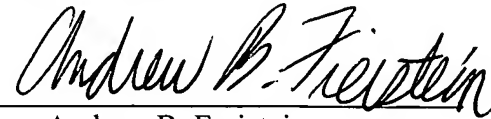
Conclusion

Therefore, in view of the foregoing amendments and remarks, it is submitted that the ground of rejection set forth by the Examiner has been overcome, and that the application is in condition for allowance. Such allowance is solicited.

Respectfully submitted,

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# Comparison between the present invention and Kazuo

|                               | Kazuo (JP2000-281438A)  | The present invention   |
|-------------------------------|---|---|
| Objective and problems        | The objective is to provide the art for strongly adhering electrode printing to the surface of zirconia sheet ---. [0008]<br>(The "adhesion property" was evaluated immediately after electrodes were formed, at least before electric generation. [0057]-[0058]) | It is an objective of the present invention to provide an electrolyte sheet for a solid oxide fuel cell which is subjected to electrode printing on its both surfaces with high adhesion property, and to improve the electric generation property of a fuel cell and to prohibit decreasing the electric generation property.<br>(The "adhesion property" was evaluated after electric generation. |
| Background art                | It is very important for a zirconia sheet to improve adhesion with electrode printed on the sheet in order to extend the life of a fuel cell. [0005]  | The publication (JP2000-281438A) contains no description of an electrolyte sheet having both acceptable adhesion to electrode printed layers and acceptable electric power generation characteristics.  |
| Means for solving the problem | The adhesion property with electrode after printing can be improved when the roughness of the sheet is adjusted in the specific range of Ry and Ra. [0014]  | The present inventors have found that, the definition of specific surface roughness can provide an electrolyte sheet having <u>both</u> acceptable adhesion of electrode layers and electric power generation property.   |
| Power generation property     | no description  | They (the sheet of the present invention) also had excellent adhesion of the electrodes, in which the electrodes were firmly attached after the electric power generation performance evaluation test (for 200 hours). In contrast, the cell formed of an electrolyte sheet with smooth surface roughness exhibited peeling in part of the electrode layers.  |
| R a                           | 0.02~0.3 μm   | 0.4~3.0 μm  |
| R y                           | 0.3~3 μm  | no description  |
| R z                           | no description  | 2.0~20 μm<br>preferably 3 μm or more; more preferably 4 μm or more  |
| R m a x                       | no description  | 2.0~40 μm   |

note) Ry in JIS is the same as Rmax in DIN

# Comparison between the present invention and Hardee

|                              | The present invention  | Hardee (US5578176)  |
|------------------------------|--|---|
| Inventive subject            | The surface of electrolyte sheet for SOFC<br>The ceramics in electrolyte sheet: stabilized zirconia and the like (p.9, l.14-18)  | The surface of oxygen evolving anodes for electrochemical reaction such as electrogalvanizing, electrofinning, electroforming and electrowinning (c.1. l.62 - c.2, l.7)<br>The material for the anode: titanium and the like (c.3. l.39-44) |
| Objective and problems       | (1) Improvement of adhesion property between electrolyte sheet and electrodes (p.1, l.7-18)<br>(2) Improvement of electric power generation characteristics of the fuel cells (p.1, l.7-18)  | Only improvement of adhesion property between oxygen evolving anode and metal (c.1. l.62 - c.2, l.7)  |
| Ra                           | Claim<br>Specification<br>0.20-3.0 $\mu\text{m}$<br>$\geq 0.4 \mu\text{m}$ , $\geq 0.5 \mu\text{m}$ , $\leq 2 \mu\text{m}$ , $\leq 1.5 \mu\text{m}$ (p.20, l.16-23)  | $\geq 6.4 \mu\text{m}$ (=250 $\mu\text{inch}$ ) (c.6, l.67 - c.7, l.2)  |
| Rz                           | Claim<br>Specification<br>2.0-20 $\mu\text{m}$<br>$\geq 3 \mu\text{m}$ , $\geq 4 \mu\text{m}$ , $\leq 15 \mu\text{m}$ , $\leq 12 \mu\text{m}$ (p.20, l.16-23)  | $\geq 25.4 \mu\text{m}$ (=1000 $\mu\text{inch}$ ), 25.4-88.9 $\mu\text{m}$ (c.7, l.22-31)   |
| Condition for use            | in gas phase, 800°C (p.50, l.19 - p.51, l.7)   | in liquid phase, 65°C (Examples)  |
| Composition in use condition | Electrolyte: the above mentioned ceramics<br>Anode: NiO/8YSZ (Example 1), NiO/10Sc1CeSZ (Example 4)<br>Cathode: La <sub>0.8</sub> Sr <sub>0.2</sub> MgO <sub>3</sub> (Cell Production Example 1), La <sub>0.8</sub> Sr <sub>0.4</sub> Fe <sub>0.8</sub> Co <sub>0.2</sub> O <sub>3</sub> (Cell Production Example 3) | Electrolyte: the mixture of sodium sulfate solution and magnesium sulfate solution (Example 3)<br>Anode: the resulting sample of Example 1 - titanium plate   |